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Assessing Native American Disturbances in Mixed Oak Forests of the Allegheny Plateau

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INTRODUCTION

Although much has been written concerning the ecology and disturbance history of hemlock - white pine - northern hardwood (Nichols 1935; Braun 1950) forests of the Allegheny Plateau (Lutz 1930a; Morey 1936; Hough and Forbes 1943; Runkle 1981; Whitney 1990; Abrams and Orwig 1996) few studies have investigated the distribution and successional dynamics of oak in this region. Most witness tree studies of the Plateau cite low numbers (<4%-20%) of oak with most occurring on droughty, south facing upper slopes (Lutz 1930b; Gordon 1940; Seischab 1990; Whitney 1990; Abrams and Ruffner 1995). Both Gordon (1940) and Kuchler (1964) mapped northward extensions of oak along river valleys into southern New York. While some oak communities may represent edaphic climaxes on poor, droughty soils (Gordon 1940; Braun 1950) we believe that these northward extensions may also reflect a presence of Native American fire and or agricultural clearing (Day 1953; Meltzer and Smith 1986; DeVivo 1991). Many researchers have reported the impact of Native American disturbances on pre-European settlement forests of eastern North America (Maxwell 1910; Day 1953; Chapman et al. 1982; Pyne 1983; Patterson and Sassaman 1988; Dorney and Dorney 1989; DeVivo 1991). Nearly all reference a patchwork anthropogenic landscape resulting from the burning of forests to reduce underbrush, girdle trees, improve wildlife browse, drive game, rejuvenate fruiting species or to clear agricultural fields.

Regional pollen sequences suggest oak was present on the southern New England landscape by 10,000-9,000 years BP (Watts 1979; Webb 1981; Davis 1983). Oak-pine forests replaced spruce-pine woodlands as early as 10,500 years BP coinciding with increased charcoal abundance and a warmer, drier climate (Miller 1973; Spear and Miller 1976; Calkin and Miller 1977; Sirkin 1977). While the role of fire in the historical development of oak is widely accepted for the mixed oak region (Lorimer 1985; Abrams 1992; Abrams and Nowacki 1992; Johnson 1992) this relationship has not been fully investigated in northern hardwood forests. Clark and Royall (1995) reported a transition from northern hardwood to white pine-oak forests during a period of Iroquois occupation and agricultural clearing. In their study of New England, Patterson and Sassaman (1988) compared sedimentary charcoal and archaeological site distributions and found fires were more common on coastal sites where Native populations were greatest and their land-use practices most intensive. In addition, they noted archaeological site distributions corresponded well with areas characterized by high oak pollen percentages (Dincauze and Mulholland 1977; Patterson and Sassaman 1988).

Recent paleoecological investigations have questioned the importance and extent of Native American fire usage in oak development (cf. Russell 1983; Clark and Royall 1996). Thus, while several regional studies suggest the correlation of fire occurrence and Native occupation with oak forest distribution more research must be completed to better understand the pre-European landscape across the northeast. In this study, we wish to gain an historical perspective for the development of oak forests on the Allegheny Plateau. Our objectives include: 1) elucidating what factors existed historically to foster oak development on the landscape, 2) identify processes whether natural and/or cultural driving oak distribution, and 3) identify successional status of current oak forests on the landscape. From this information, we hope to increase our knowledge of presettlement forest conditions and develop ways we can maintain and preserve oak areas on the Allegheny Plateau.

This project integrates several disciplines to answer these questions. Palynological analysis of bog sediments will identify changes in species composition over time as well as provide charcoal evidence of previous fire events needed for radiocarbon dating. Archaeology is providing information on Native American settlement and land-use patterns while witness tree analysis and historical data help to identify pre-European settlement forest conditions. We believe a study of this scope conducted in this region will provide some compelling information concerning Native American impacts on the forest resources of the Allegheny Plateau prior to European settlement.

STUDY AREA

The region comprises the Unglaciated High Allegheny Plateau characterized by broad flat-topped ridges deeply dissected by dendritic streams (Bowman 1911; Fenneman 1938). Soils are predominantly Inceptisols formed in residuum and colluvium from Mississippian and Pennsylvanian aged sandstones and shales (Cerutti 1985; Ciolkosz et al. 1989). Hazleton-Cookport soils occur on plateau uplands while Hazleton-Gilpin-Ernest soils dominate riparian sideslopes. Both are characterized as deep, well drained to moderately well drained, sloping to moderately steep soils formed from acidic sandstone and shale. Alluvial floodplains and glacial outwash terraces consist of Wayland-Chenango-Braceville soils and are characterized as deep, very poorly drained, level to gently sloping soils formed in water deposited materials derived from acid sandstone and shale (Cerutti 1985). Climate of the region is typified as cool and humid. Average temperatures range from 20û C in the summer to -2û C in the winter months. Total annual precipitation is 109 cm with 61 cm falling during the growing season between April and September (Cerutti 1985).

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PRELIMINARY RESULTS

Archaeological Evidence

Located within the study area are 55 pre-contact and 54 post-contact archaeological sites. Several included in the Buckaloons Historic District (BHD) are regarded as the most significant archaeological sites in Pennsylvania. Prehistoric artifacts from collections coupled with evidence from extensive field projects conducted within the study area suggest human occupation for the last 12,000 years. The area was first occupied by PaleoIndians during the retreat of the Wisconsin ice sheet between 12,000 to 11,000 y BP. As the ice retreated, Paleoindians advanced northward along the Allegheny River from the southern portion of Pennsylvania and Ohio following megafauna and other game (Funk 1993). It is widely held that seasonal hunting patterns operated on a north/south directional flow along major waterways. Vegetation composition and distribution changed as the glacial margin moved northward. Tundra-like conditions existed until around 12,000 y BP when replaced by open stands of spruce and by 10,500 y BP pine-oak forests dominated the landscape coinciding with increased charcoal abundance and a warmer, drier climate. These environmental changes certainly affected human resource collection and utilization. For instance, it is believed that by this period large megafauna such as the mastodon (*Mammut americanus*) had been extirpated and other mammals such as the caribou, moose, and deer comprised much of the diet of the inhabitants. Further, the collection of acorns, walnuts, and hickory nuts is recognized as another subsistence pattern of the Early Archaic period (Munson 1986).

A scarcity of Middle Archaic (c. 8000-6000 y BP) sites and artifacts indicates either a lower population in the area or that specialists have not been able to differentiate Middle Archaic artifacts from those of adjacent periods (Stewart and Kratzer 1989; Quinn and Adovasio 1996). The pollen record for western New York indicates a decrease in pine distribution and an increase in hemlock during this period (Trubowitz 1983). Although speculative, changes in species distribution may have affected faunal migration/population patterns thus impacting human migration/population patterns. However, by the Late-Archaic (6000-3000 y BP) northern hardwood and mixed oak forests dominated the landscape. At this time Peoples of the Brewerton and Lamoka cultures (Laurentian Tradition) inhabited the region. Brewerton peoples were adapted to the upland environments while the Lamoka peoples preferred riparian areas. Both cultures are characterized with hunting, gathering, and foraging subsistence strategies. Seasonal base camps have been identified on both the upland and riparian environments. Despite information concerning cultural developments, human-environmental interactions are not presently understood.

In northwestern Pennsylvania, agriculture developed during the Woodland Period (3,000-300 y BP) and was practiced extensively by the Seneca-Iroquois nation by 1350 AD (Dennis 1993; Snow 1994). The Iroquois practiced a form of swidden agriculture in which forests were cleared and burned to create open areas (Ketchum 1864; Parker 1968). Cultigens included the sunflower (*Helianthus annuus*), maize (*Zeas mays*), squash (*Curcubita* spp.), and beans (*Phaseolus vulgaris*) (Dimmick 1994; Snow 1994). Crops were cultivated in cleared fields extending out from a central village. Fields were cultivated for several years (8-12) until crop harvests decreased enough to warrant moving the village to another streamside site (Ritchie and Funk 1979; Sykes 1980, Snow 1994). The ability to raise crops reduced the dependence on hunting and gathering. In addition, agriculture was responsible for a sharp increase in population and development of a more sedentary existence evidenced by the development of large villages (Snow 1994).

Most occupation sites occurred on river or glacial outwash terraces and ranged in size from small clan hamlets of three or five longhouses capable of supporting 15-20 persons to villages encompassing ten longhouses on 8-10 acres supporting 150-200 people (Witthoft 1965; Ritchie and Funk 1979; Snow 1994). Nearly all Iroquois settlements were palisaded for protection (Snow 1994). These palisades consisted of large posts averaging one foot in diameter, with an upper limit of two feet (Ritchie and Funk 1979). According to the size of the village protected, constructing these defensive perimeters required a considerable amount of timber not to mention the quantity of fuelwood needed by the inhabitants.

Thus, over time, the anthropogenic landscape would resemble a mosaic pattern of (1) croplands near palisaded settlements, (2) abandoned clearings with early successional taxa, and (3) open forest stands dominated by fire adapted species such as oak and hickory (Chapman et al. 1982). Indeed, many paleoecological studies have identified a transition from later successional species to early successional species during the period of Native American burning and occupation (Chapman et al. 1982; Delcourt 1987; Clark and Royall 1995).

Witness Tree Analyses

Presettlement forest conditions were characterized by tallying corner trees from original warrant maps (1790-1820). Warrant maps represent a tract of land as surveyed at the time of first settlement (Munger 1991). Each warrant map comprises several bearings and distances linking property corners, either marked trees, posts, or stone monuments. After the tract was surveyed, a warrant map was produced illustrating the configuration of the lot, including boundary-line descriptions, property corners, whether trees or otherwise, and other outstanding geographic features such as streams, mountain peaks, or "Indian" paths (Abrams and Ruffner 1995). For this study, individual warrants and their corresponding witness corners were overlayed on USGS 7.5- min. quadrangle maps or identified on previously delineated boundary lines on USFS 7.5-min. quadrangle topographic maps. These connected drafts provided the main source for tallying the corner trees by species and physiographic landform (e.g. stream valley, north cove, plateau top, etc.).

Witness tree-topographic relationships were examined using contingency table analysis, a method which tests for

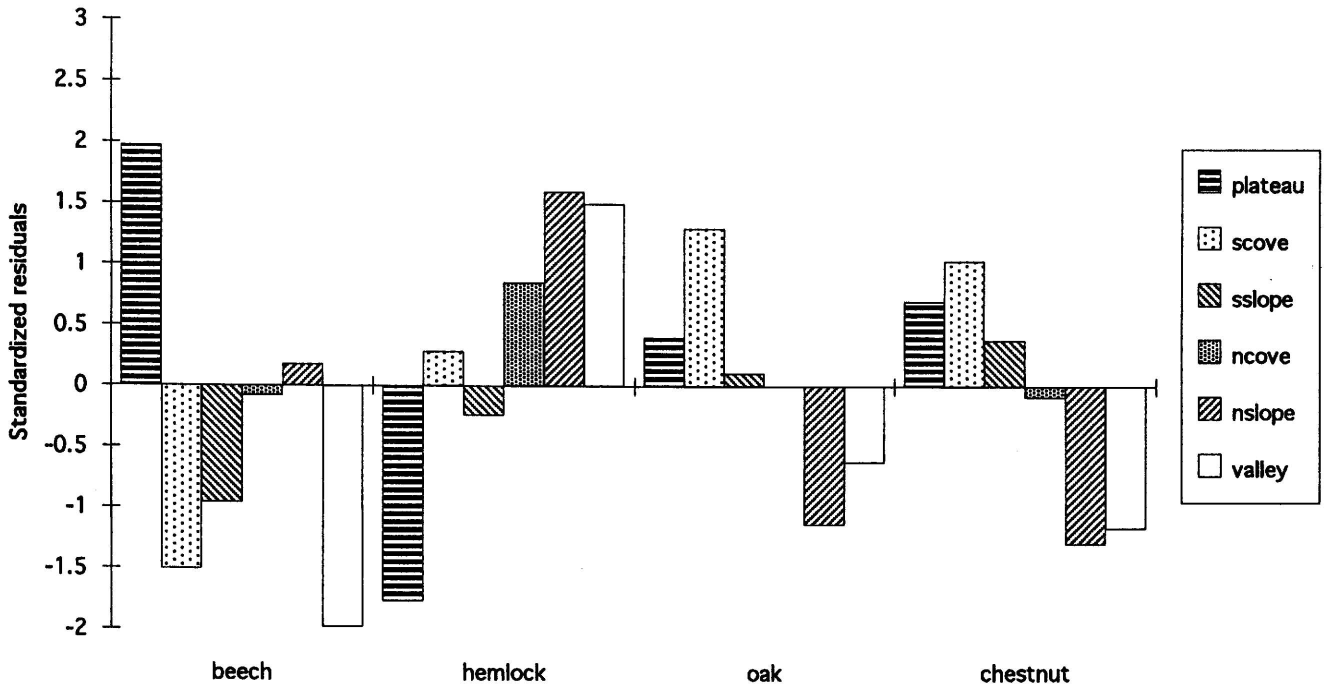

Figure 1.—Significant associations (p<0.01) of representative tree species on various landforms of the Allegheny Plateau. Positive and negative values indicate a preference or avoidance, respectively, for the landform.

independence between topographic position and the presence.abscence of a species (Strahler 1978). This test is performed by calculating the likelihood-ratio chi-squared statistic, G^2 and comparing this value to the appropriate quantile of the chi-squared distribution (Agresti 1996). Standardized residuals were calculated following Haberman's method (1973) for contingency tables revealing significance. Residual values quantify a species preference (positive) or avoidance (negative) of a particular topographic position (Whitney 1990).

Analysis of species-site relationships with standardized residuals provided some compelling information concerning species distributions on the Allegheny Plateau. When witness trees across the Allegheny Plateau were used, species distributions conformed nicely to current distributional conventions (Figure 1). For instance, American beech (*Fagus grandifolia* Ehrh.) dominated the plateau uplands while oaks and chestnut (*Castanea dentata*) dominated xeric, south facing slopes. Hemlock (*Tsuga canadensis*) in contrast, was cited most often on mesic slopes and valley/riparian sites.

Following this, witness tree distributions were separated into two zones, west and east of Minister Creek. This boundary was utilized because Minister Creek appears to be a major watershed roughly marking the edge of Native occupation east of the Allegheny River. Thus, witness trees were again tallied by site in these two regions, west and east of Minister Creek. Standardized residuals of species-site relationships reveals significant changes in species distributions (Figures 2 & 3). Ninety-three percent of all oaks and eighty-three percent of all chestnuts tallied occurred west of Minister Creek dominating the plateau uplands and south coves. In contrast, beech is limited to mesic slopes and is virtually absent from the upland plateau. Hemlock is relegated to mesic, protected cove sites. We believe this distinct shift in species on the uplands is a result of Native burning on these sites. Frequent burning would have selected for fire adapted species such as oak and chestnut with their thick fire resistant, corky bark. Further, archaeological sites occur more frequently in the oak-chestnut dominated uplands west of Minister Creek (Figure 4). Species distributions east of Minister Creek are very similar to those cited above for the Allegheny Plateau (Figure 3). Beech again dominates the upland plateaus while oak and chestnut numbers are limited to 6 (7%) and 7 (17%), respectively. We hypothesize that the level of disturbance, particularly fire, was reduced east of Minster Creek and thus late successional beech outcompeted oak and chestnut on the plateau uplands. Further, while some archaeological sites occur east of Minister Creek, they are not as widespread or frequent.

Historical Data

Historical documents such as explorer and missionary accounts, surveyor notes, military journals, and deeds are being searched for information concerning forest conditions and disturbances which may include for instance, Native fires, timber cutting, or agricultural practices. Thus far, early French explorers noted tall-grass prairies along the Irvine Flats of Brokenstraw Creek in Warren Township suggesting a portion of the prairie peninsula may have reached this area (Schenk 1887; Transeau 1935). In 1749, the French Government

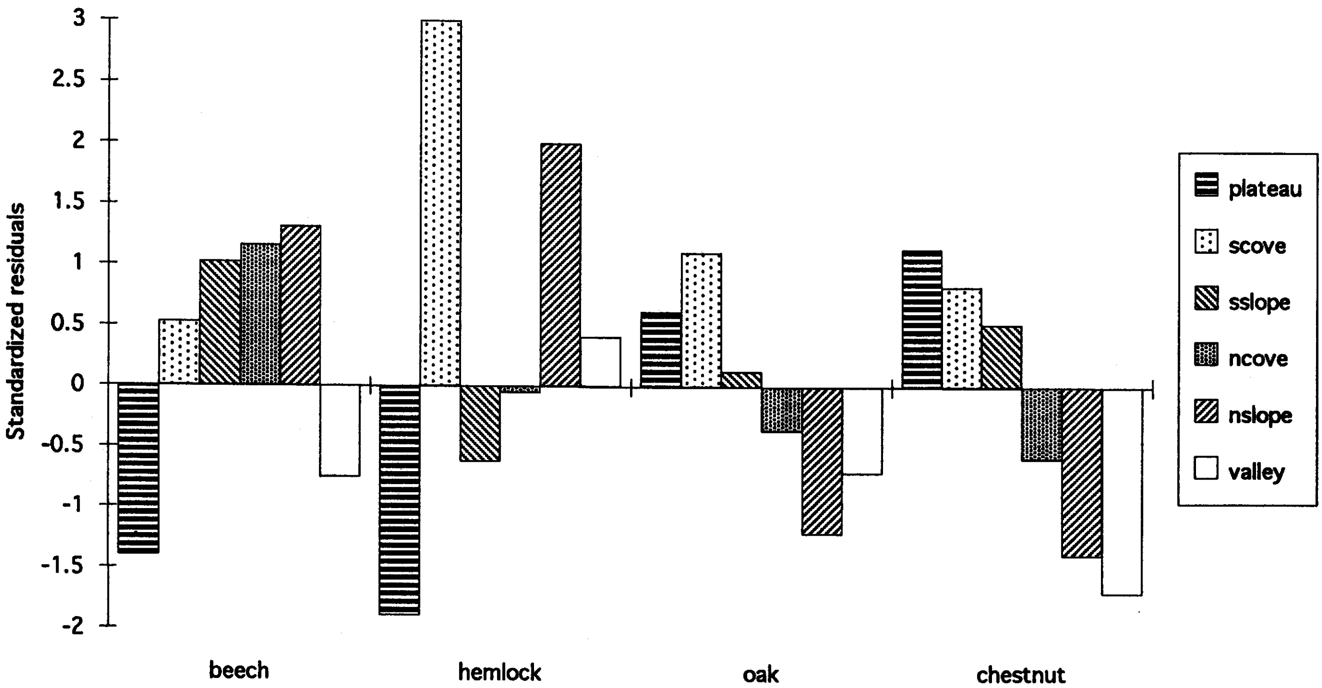

Figure 2.—Significant associations (p<0.01) of representative tree species on various landforms west of Minister Creek. Positive and negative values indicate a preference or avoidance, respectively, for the landform.

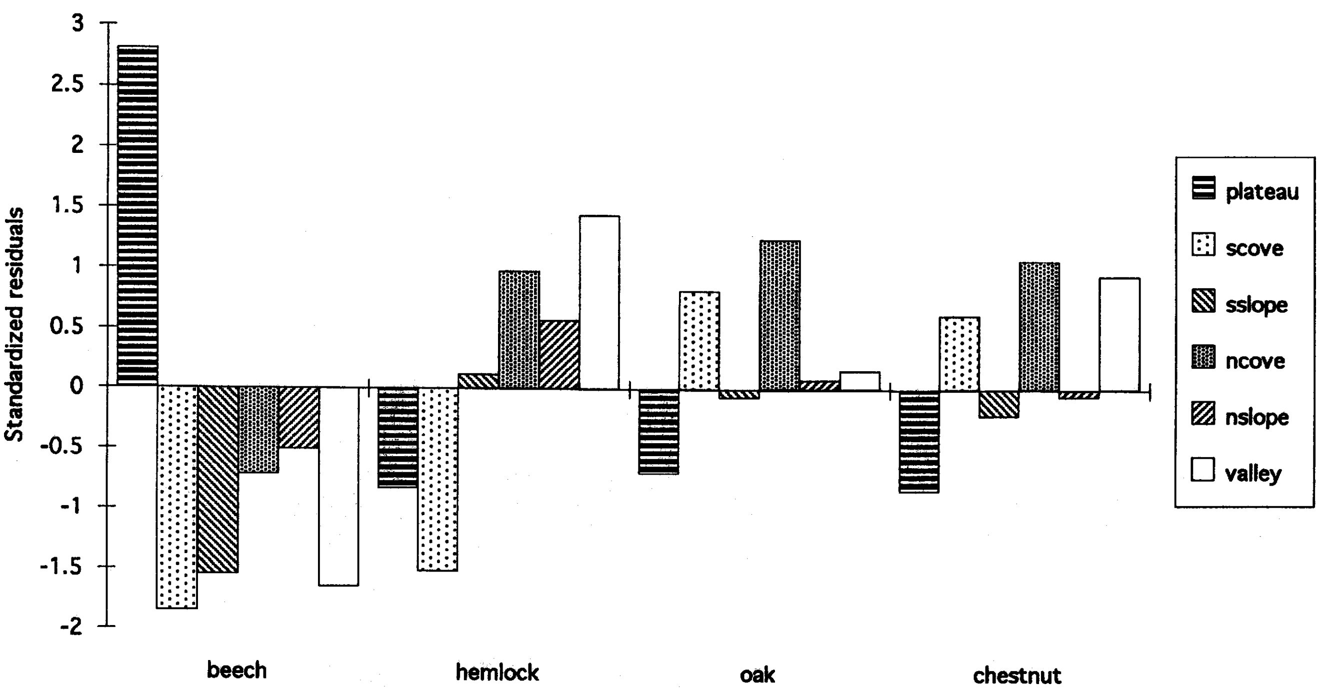

Figure 3.—Significant associations (p<0.01) of representative tree species on various landforms east of Minister Creek. Positive and negative values indicate a preference or avoidance, respectively, for the landform.

dispatched Captain Bienville de Celeron to officially claim the lands of the upper Ohio (Allegheny) River. While environmental information is sparse in these accounts, locations of Native villages are well described. Early travelers in western New York reported "oak openings" in areas previously inhabited by the Seneca (Ketchum 1864; Sagard 1865).

PRESETTLEMENT FOREST TYPES OF MINISTER CREEK AREA

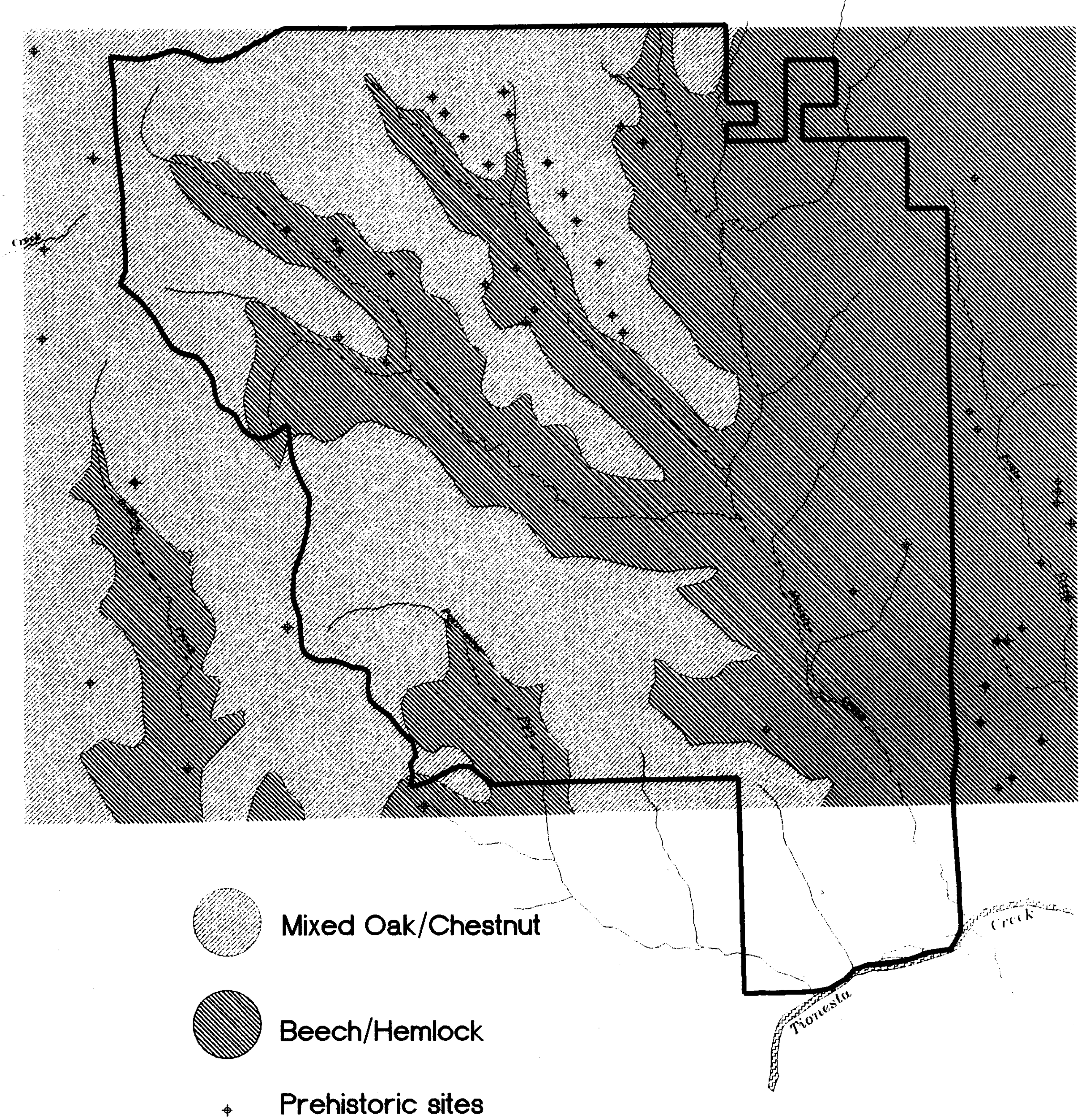

Figure 4.—Presettlement forest types of Minister Creek area with archaeological site distributions. Sites on east side of Minister Creek are camps exhibiting low intensity usage while sites on the west side are characterized by larger rockshelter complexes having extended histories.

Pollen Analysis

The basic assumption of pollen analysis is that the types of pollen depositied at a site represent the range of species growing in the area (Davis 1963; Fagrei and Iversen 1975). The large quantity of pollen mixing in the atmosphere before deposition is assumed to yield a pollen assemblage characteristic of the type of forest or other vegetation that produced the pollen (Kellogg and Custer 1994). Thus, changes in pollen frequencies through time represent changes in vegetation through time (Kellogg and Custer 1994). An exploratory bucket auger sample has been taken and is being analyzed for pollen preservation from the Jones Run bog. A sample from 1.4 m has been submitted for radiocarbon dating. The site appears to have the potential to yield a vegetation record spanning the last few thousand years. The basal unit is sand-gravel channel deposits, overlain by silt-clay overbank sediments, and capped by sphagnum peat—totaling about 1.5 meters of sediment.

FUTURE WORK

This project is essentially in the implementation stage and final results will not be available until the pollen analysis and archaeological excavations are complete. The authors have developed this study to assess the existence and extent of Native American impacts on natural resources of the Allegheny Plateau. We believe this integrative approach could be utilized in other regions to better understand the long term vegetational changes on the landscape and assess cultural adaptations or disturbances responsible for the anthropogenic landscape encountered by EuroAmericans during westward expansion.

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